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ABSTRACT

This paper presents a model that was developed for the categorization and evaluation of stand-alone interactive media and that now is used to contribute to a more detailed and specific educational discussion of Internet use. The paper begins with a review of the foundations on which the model is built, including software as subject, tool, or medium and the three dimensions of the learning model--learning/teaching, action, and social organization. The following types of Internet applications are then discussed from the perspective of the learning model: (1) learning facts and rules (remember, receive); (2) rules, procedures (apply, imitate); (3) problem solving (decide, select); (4) Gestalt perception, pattern recognition (explore, understand); and (5) complex (real) situation (invent, master, cooperate). Existing World Wide Web sites are described as examples in each category. Features that distinguish Internet applications from stand-alone educational software are summarized. Two figures illustrate the three-dimensional heuristic model of learning and social organization of the learning process. (DLS)

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Learning with the Internet
A Typology of Applications

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Abstract: Reflection on the forms and possibilities of Internet use in education does not keep pace with the speed with which access for schools is provided worldwide. For an in-depth educational discussion, we need to differentiate types of Internet applications. We will present a model that was developed for the categorization and evaluation of (stand-alone) interactive media ([Baumgartner 1995] [Baumgartner and Payr 1994 and 1996]) and that we use now to contribute to a more detailed and specific educational discussion of Internet use. After a short review of the foundations on which the model is built we will illustrate its application to the Internet, using existing sites as examples.

1. Internet as medium, Internet as tool

In order to submit the multitude of Internet services and applications (like e-mail, Telnet, FTP, Gopher, WWW, mailing-lists, newsgroups, chats, computer supported collaborative work etc.) to theoretical inspection, we have to distinguish between three basic aspects of software use, namely as
i - subject
ii - tool or
iii - medium

i) Software entered the classroom as a subject: programming languages, application software and the like. The issue was to learn the use of software and to train skills and qualifications that were deemed necessary for the labor market.

ii) Software is considered a tool (cf. [Taylor 1980]) if it is not the skilled use of an application etc. that is in itself the issue, but the use of application software to realise student projects and carry out tasks in various subjects (e.g. publication of a student newsletter or design of a database for collected data). This kind of

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software use is characteristically „pedagogically neutral", that is, the design of the educational setting remains completely open. Of course, using software to do a certain job presupposes a certain mastery of it, so that acquisition of the necessary skills (as in i)) is often integrated in the tool aspect.

iii) Software is a medium in those cases where the software itself transports contents (educational software in its broadest sense). Applications range from simple vocabulary drills to complex simulations. In this aspect, the software is not pedagogically neutral, but always transports (often implicit or hidden) theories about the user's learning process.

The medium aspect is the central domain with which the discipline of educational technology usually deals. The first part of our discussion of Internet applications will also fall into this domain, for which especially the multiple uses of the WWW are typical.

2. Dimensions of the Learning Model

The heuristic model of learning that we have proposed before ([Baumgartner and Payr 1996]) is based on work by Dreyfus and Dreyfus [Dreyfus and Dreyfus 1987] who distinguish five steps in the learning process – from novice via (advanced) beginner, competence, fluency to expertise. Starting from these steps, we have opened up the model to three dimensions: action (of the learner), teaching/learning, and organisation of the learning process [figure 1].

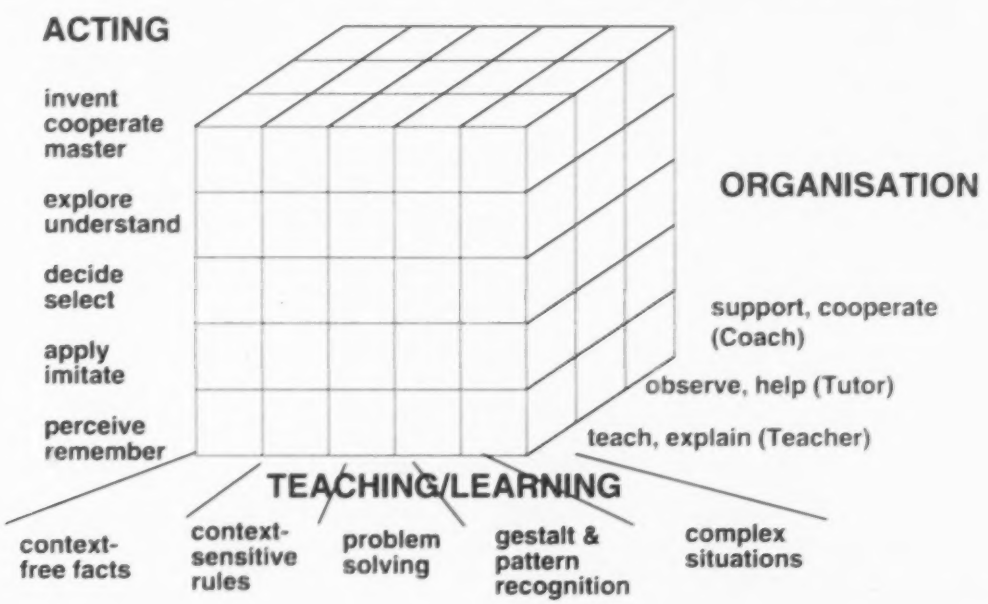

Figure 1: A 3D heuristic model of learning

The dimensions of the heuristic model needs some further explanation:

Learning/teaching dimension: With its help, rough definitions of subjects and learning goals (e.g. „solving equations") can be refined. For example: Should the students be able to solve equations following a certain method, should they also be able to choose the method, or should they even learn to construct systems of equations out of everyday situations (text description)? In the first case, the contents are context-free rules (level 1). In the second case, the rules to learn are context dependent (level 2). Level 3, in this example, would mean solving whole systems of equations, using and selecting all the rules and methods available. On the highest levels, the problem has first to be constructed from a real world situation so that it can be solved with the known methods.

Dimension of action: This dimension lists the forms and possibilities of interaction between the learner and the „world" (society) and recognizes that novices are not able to „take in" a complex situation as a whole. This can be easily misunderstood as an old-fashioned hierarchical conception of learning, whereby novices have first to rote-learn facts or be drilled in rules until they can finally pass on to more complex tasks. But this is not what we mean: this dimension should rather reflect the experience that learners develop themselves strategies for interacting with the world, obviously in order to avoid stress and information overload.

Dimension of social organisation: This dimension describes the role of the teacher, but also that of the media: are they „teacher" (= explain, demonstrate), „tutor" (= observe, help) or „coach" (= accompany, cooperate)? [figure 2].

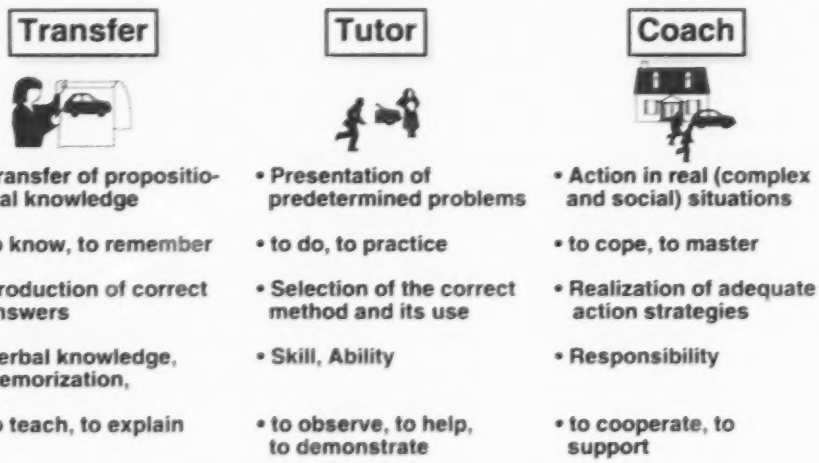
Transfer
Tutor
Coach
• Transfer of propositio-nal knowledge
• to know, to remember
• Production of correct answers
• Verbal knowledge, Memorization,
• to teach, to explain
• Presentation of predetermined problems
• to do, to practice
• Selection of the correct method and its use
• Skill, Ability
• to observe, to help, to demonstrate
• Action in real (complex and social) situations
• to cope, to master
• Realization of adequate action strategies
• Responsibility
• to cooperate, to support

Figure 2: Social organisation of the learning process

3. Internet Applications and the 3D Model

We will now try to distinguish types of Internet applications from the perspective of the learning model:

1. *Learning facts and rules/remember, receive:* every application whose main purpose is to present and transfer contents (verbal, multimedia) falls into this group. Most of the Web, being a networked information resource in the first place, thus falls into this category. The main activity of the user (interaction) is to navigate among pieces of information.

> *Example:* The examples for this type of application are therefore very numerous, almost as numerous as the number of web sites of institutions, electronic journals, project presentations, companies etc. There are, among them, also lots of sites with educational contents and goals, as for example the exhibition „Auschwitz – Terminal to Holocaust" (Auschwitz – Endstation Vernichtung, [http://www.wsg-hist.uni-linz.ac.at/Auschwitz/HTML/Seite1.html], last access 04-04-98), created and realised in the Web at the University of Linz/Austria. This site has a simple and predominantly hierarchical structure. From the index, the user can visit the different chapters, composed of authentic photos and easy-to-read texts. Difficult terms e.g. expressions that were coined by the prisoners, can be looked up in a glossary by clicking on them.

2. *Rules, procedures/apply, imitate:* Internet applications falling into this group are characterised by exercises and tests. They do not only present contents but also offer the users interactive possibilities to control whether they are able to apply what they have learned. The learner acquires and tests procedural knowledge.

> *Example:* We chose the „Waste Management Game" as an example for such an application (Mülltrennungsspiel, [http://www.kraftwerk.co.at/mllmanagerspiel.html], verification unsuccessful on 04-04-98!). In the training section the user selects different types of waste (e.g. spraycans, oil, fax paper ...) and the correct type of wastecan is demonstrated graphically. In the quiz part, the user must himself „throw away" correctly randomly presented objects and substances.

3. *Problem solving/decide, select:* This group of applications deals with more complex problems that have to be solved in the Internet. While on the lower level, individual steps and operations were presented, trained and tested, the learner now has to select herself the steps and procedures.

> *Example:* Tutorials containing tasks and interactive practice, e.g. the hypertext textbook accompanying the VSNS BioComputing Course at the University of Bielefeld ([http://www.techfak.uni-bielefeld.de/bcd/Transfer97/welcome.html], last access 04-04-98). This textbook is the cornerstone of a complex media-supported distance course. It contains assignments that the students have to submit on Web forms. However, the assignments are not analysed automatically but by the teachers and tutors who use electronic communication to give feedback and support. This integration of human tutors is a good solution to the long-standing and mostly unsolved problem of analysing and supporting automatically the complex learner actions and decisions on such an advanced level of learning.

4. *Gestalt perception, pattern recognition/explore, understand:* open learning environments and simulations are applications supporting learning processes on

this level. The goal is to perceive and understand holistically processes with their causes and effects, and to discover common characteristics and pattern in diverse „cases".

Example: An interesting example for such an environment is the Open University's „Art Explorer". An article with interactive demonstrations is openly accessible in the Internet ([http://www-jime.open.ac.uk/jime/01/jime-01.html], last access 04-04-98). The Art Explorer is an interactive introduction to the history of art. The main purpose is awareness of old and acquisition of new „habits" of seeing. The tasks include grouping of pictures, developing 3D patterns from geometrical forms, or transforming individual objects and figures in paintings. There is no pre-defined solution and no feedback for the individual tasks. The goal is to support students in the acquisition of „seeing skills" without feeling controlled by external interpretations.

The site „Wild Wings Heading North" ([http://north.audubon.org/], last verified 04-04-98) is quite a different application also falling into this group. The project was designed specifically for schools: In spring 1997, ten wild geese were caught and marked with transmitters. Their signals were detected as they pursued their northward migration towards Canada and Alaska. The route and current position of each goose could be requested via the Internet, where they appeared on a map of the U.S. so that children were able to accompany „their" favorite goose. Background information on habits and migrations of wild geese, a discussion forum and a little game where children could make their bet on the way a certain goose would take next accompanied the maps. By its very nature, the „result" of this project was completely open, even for the researchers involved. Nobody knew at the start how many of the geese (or of their transmitters!) would survive the yearly migration and where they would travel. The site made it possible to discover and understand a phenomenon of natural life beyond the limits of space and time.

5. Complex (real) situation/invent, master, cooperate: Internet applications on this level typically are the very tools that experts use in their work. They can also be adapted „student" versions that introduce students to the use of the full-fledged tools. Some sections of the above mentioned BioComputing Course fall into this group, namely the integration of international online databases of DNS sequences. These databases are commonly used by researchers to check whether a certain sequence is already known and registered.

Another typical application is the „CyberLab" of the University of Osnabrück ([http://marvin.physik.uni-osnabrueck.de/CyberLab/], last verified 04-04--98), running an experiment that studies magnetic surfaces and layers. The computer controlling the experiment and processing its data can be directly accessed via the Internet (observation is open for all, but – of course – only authorised users can actively control and modify the experimental setting). The experiment can be run from a distance by all the associated researchers. The data are not only presented graphically (in as real time as the Internet permits), but are also logged in files that the remote researchers can analyse afterwards. Such remote experiments or even complete virtual labs will be of increasing importance in the Internet: they can help to use more economically the increasingly complicated and costly lab equipment, making it available to a large number of researchers and students simultaneously.

On this level of learning, we would also have to mention all the Internet services for communication and cooperation (like newsgroups, mailing-lists, online chats or Internet tools for CSCL, e.g. the Basic Support for Collaborative Work developed by the German

National Research Center for Information Technology GMD [http://bscw.gmd.de/]) when they are used for cooperative work on student or research projects.

Finally, the Web itself, seen as a whole, is a real and indeed complex situation. Its contents are „real" (that is, not specifically selected, processed and/or simplified for educational use). With the Internet, the „world" enters the classroom more massively than ever before, creating new problems and challenges. Mastering this situation demands new skills. We do not mean technical or programming skills here, but the skill to arrange, analyse and evaluate huge amounts of information and to use them for one's own learning and knowledge.

4. Internet: Chances and Challenges

The examples discussed before can also be used to illustrate the features that distinguish Internet applications from stand-alone educational software:

- *Integrated media and (communication) tools*: A complex learning environment like the BioComputing Course contains not only information resources and interactive software, but also tools specifically tailored to communication and teamwork among participants. This seamless integration of interactions with software and interactions with teachers/co-students is only possible in the network and offers new possibilities for the design of technology supported social settings for learning.
- *Up-to-date information*: Accompanying the wild geese continuously on their migration would hardly be possible without the Internet. In the Internet, the signals and data need only be processed in one place while being accessible from everywhere at any time and on demand.
- *Accessibility*: Other examples like the waste management game could be equally used locally and distributed traditionally. But this is only true if we look at one application at a time. The added value of the Internet is to be sought on another level: namely by making applications like this one accessible to everyone, easy to use and cross-platform portable.

The learning model that we have used here to distinguish Internet applications can be seen as a first orientation for the design of media supported learning situations. Starting with the types of Internet applications and their features, teachers are able to ask concrete questions concerning their target group and to develop, from there on, models for the educational uses of the Internet. The complexity of the information resources, the multitude of interaction types and the integration of media and tools are the new challenges for the teacher. At the same time, the Internet, with its possibilities for networking and cooperation, also offers possibilities to answer to these challenges.

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